CLARIAS LAMOTTEI (SILURIFORMES, CLARIIDAE), A NATURAL INTERGENERIC HYBRID FROM WEST AFRICA

by

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ABSTRACT. - A biometric study of four *Clarias* and two *Heterobranchus* species and including the type material of *C. lamottei*, only known by its types, showed that the latter is most probably a natural hybrid between *C. gariepinus* and *H. isopterus*. Zoogeographical evidence is given to support this.

RÉSUMÉ. - *Clarias lamottei* (Siluriformes, Clariidae), un hybride naturel intergénérique d'Afrique de l'Ouest.

Une étude biométrique de quatre espèces de *Clarias* et deux espèces d'*Heterobranchus* et comprenant le matériel type de *C. lamottei*, espèce connue uniquement par ses types, a montré qu'il s'agit très probablement d'un hybride naturel entre *C. gariepinus* et *H. isopterus*. Des données zoogéographiques supportent ces résultats.

Key words. - Clariidae - *Clarias* - *Heterobranchus* - Intergeneric hybrid - Morphology - Zoogeography.

Clariidae are airbreathing catfishes, naturally occurring in Africa, Minor and South-East Asia. Their diversity is highest in Africa, where 12 genera with 74 species are known; only three genera with about 18 species occur in Asia (Teugels, 1996). The monophyly of the family has not been demonstrated, but the suprabranchial organ is most likely the synapomorphy uniting them (Teugels and Adriaens, in press).

Heterobranchus Geoffroy Saint-Hilaire, 1809 is generally considered the most primitive genus, mainly because of the presence of a large (22-35% standard length) adipose fin supported by 19 to 26 elongated neural spines. Four valid species, all endemic to Africa are known (Teugels, 1983a; Teugels *et al*., 1990). *Clarias* Scopoli, 1777 is the most speciose genus; Teugels (1986) recognised 32 valid *Clarias* species in Africa and arranged them in 6 subgenera. All subgenera lack an adipose fin, except for *Clarias (Dinotopteroides)* Fowler, 1930, diagnosed by the presence of a small (6-16 %SL) adipose fin, supported by 6 to 12 elongated neural spines. Two species are recognized in this subgenus: *C. ngamensis* Castelnau, 1861, from southern Africa and *C. lamottei* Daget & Planquette, 1967, only known from the holotype and three paratypes all originating from the Nzi River in Côte d'Ivoire, West Africa (Teugels, 1986).

Fragmentation of a formerly more widespread distribution of the *Clarias (Dinotopteroides*) lineage, followed by speciation events amongst the isolated populations and the extinction of some taxa would have led to the present-day disjunct distribution (Teugels, 1983b). Zoogeographically however, this hypothesis remains difficult to accept, especially as no similar distribution pattern could be found in other living organisms.

Legendre *et al*. (1992) published on the artificial hybridisation between *Clarias gariepinus* (Burchell, 1822) and *Heterobranchus longifilis* Valenciennes, 1840. The external morphology of the reciprocal hybrids is intermediate between that of the parents: they all have a small (14-19 %SL) adipose fin, supported by 15 to 17 extended neural spines.

The striking resemblance between this artificial hybrid and *C. lamottei* may lead to question the validity of the latter. In this paper we morphologically examine the type material of *C. lamottei* and compare it to that of the artificial hybrids between *C. gariepinus* x *H. longifilis*, and to that of sympatric *Clarias* and *Heterobranchus* species that could possibly have been involved in an hybridisation. A comparison with *C. ngamensis* is also made.

MATERIAL AND METHODS

One hundred and twenty five specimens were examined. They represent four *Clarias* and two *Heterobranchus* species and the artificial reciprocal hybrids between *C. gariepinus* and *H. longifilis*, obtained by Legendre *et al*. (1992). All the material is housed in the Muséum national d'Histoire naturelle (MNHN, Paris, France) and in the Musée Royal de l'Afrique Centrale (MRAC, Tervuren, Belgium). Details on the material examined are given in table I.

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Species	N	Standard length (mm)	Origin
C. anguillaris	29	120-415	West Africa
C. gariepinus	30	97-325	West Africa
C. lamottei	4	104-141	Côte d'Ivoire
C. ngamensis	22	74-347	Southern Africa
H. isopterus	29	73-310	West Africa
H. longifilis	27	57-306	West- and Central Africa
C. gariepinus x *H. longifilis*	13	64-485	Côte d'Ivoire

Table I. - Number of specimens (N), the minimum and maximum standard length and origin of the material for the *Clarias* and *Heterobranchus* species examined.

On each specimen these 13 measurements were taken using dial callipers: standard length, head length, interorbital width, width of the premaxillary toothplate, width of the vomerine toothplate, length of the vomerine toothplate, predorsal length, preanal length, prepelvic length, prepectoral length, dorsal fin length, distance between dorsal and caudal fins, and distance between occipital process and dorsal fin. Measurements follow Teugels (1986) and Teugels *et al*. (1990). Gill raker number on the complete first branchial arch, and dorsal and anal fin rays were counted on each specimen. The choice of these measurements and counts is based on their diagnostic value, demonstrated in previous work (Teugels, 1986; Teugels *et al*., 1990).

Data were submitted to basic statistical analysis. Next principal component analysis (PCA) was used for the morphometric data. For practical application and interpretation of the results, the method of Humphries *et al*. (1981) as developed by Bookstein *et al*. (1985) was adopted. Data were log-transformed to minimise effects of non-normality before PCA was run on the covariance matrix; missing data were casewise deleted. The first principal component was interpreted as a size factor and was not taken into account in order to minimise the effect of size differences between the samples. The other components were considered as shape factors, independent of size and have been considered. The STA. STATISTICA (StatSoft Inc.) version 4.5 package was used.

RESULTS AND DISCUSSION

The type-material of *C. lamottei* was collected in a temporary pool connected with the Nzi River, an affluent of the Bandama Basin in Côte d'Ivoire (Daget and Planquette, 1967). Teugels *et al*. (1988) reported four other *Clarias* species and two *Heterobranchus* species from this basin. Two *Clarias* species (*C. buettikoferi* Steindachner, 1895 and *C. ebriensis* Pellegrin, 1920) have been excluded from this study because they differ considerably from the other species treated herein in several diagnostic features (see Teugels, 1986 for details).

Most important morphological differences between the remaining *Clarias* [*C. anguillaris* (Linnaeus, 1758), *C. gariepinus* and *C. ngamensis*] and the *Heterobranchus* species (*H. longifilis* and *H. isopterus* Bleeker, 1863) are related to the dorsal fin length and consequently also to the distance between the dorsal and the caudal fins (= adipose fin length in *Heterobranchus*). These variables are not subject to allometric variation (Teugels, 1986). Figure 1 illustrates the relation between these variables in the different taxa examined: the *Heterobranchus* species have a dorsal fin length (26.0-34.5 %SL) almost equal to the distance between dorsal and caudal fins (27.2-34.6 %SL) ; *C. gariepinus* and *C. anguillaris* have a long dorsal fin (58.0-66.6 %SL). Both the *C. lamottei* types and the artificial *C. gariepinus* x *H. longifilis* hybrids have an intermediate position between *Clarias* and *Heterobranchus* (dorsal fin length 44.3-50.2 %SL) but the distance between dorsal and caudal fins seems smaller in the C. *lamottei* types. *C. ngamensis* has a dorsal fin length which is intermediate between that of the *C. lamottei* types and the artificial *C. gariepinus* x *H. longifilis* hybrids and the remaining *Clarias* species. The morphometric data are corroborated by the dorsal fin ray counts (Fig. 2): *Heterobranchus* species have 26 to 36 dorsal rays; *C. anguillaris* and *C. gariepinus* have 62 to 80; the *C. lamottei* types have 53-58, while the *C. gariepinus* x *H. longifilis* have 46-54; *C. ngamensis* has 56 to 62.

For the assessment of the morphometric affinities between *C. ngamensis* and the other taxa examined, figure 3 illustrates the plot of the second and the third factor of a PCA using 12 log-transformed morphometric data (see materials and methods, excluding standard length), taken on 113 specimens of all taxa examined (specimens with an incomplete data set, were not included). All *C. ngamensis* specimens are located on the negative sector of the third factor. This factor is defined (in decreasing order of importance) by the length of the vomerine toothplate, the width of the premaxillary toothplate, the distance between the occipital process and the dorsal fin and the width of the vomerine toothplate. Factor 3 explains 4.28% of the total variance. In the same plot, most *C. anguillaris* and *C. gariepinus* specimens are located on the negative sector of the second component, while most *H. longifilis* and *H. isopterus* specimens are located on the positive sector of this factor. The second factor, explaining 13.28% of the total variance, is defined (in decreasing order of importance) by the distance between

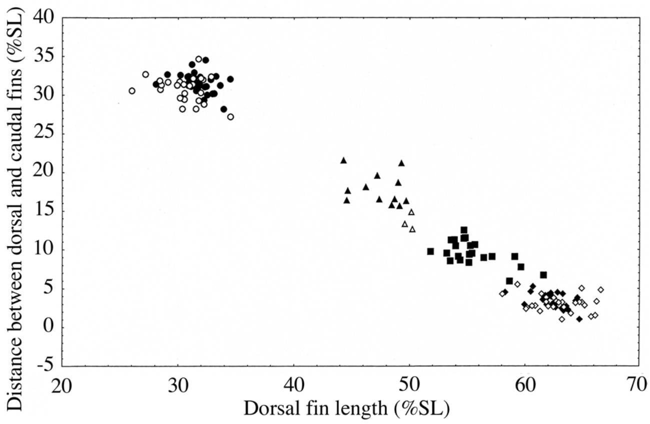


Figure 1. - Relation between dorsal fin length (in %SL) and distance between dorsal and caudal fins (in% SL). ○ = *H. longifilis*; ● = *H. isopterus*; ▲ = *C. gariepinus* x *H. longifilis*; Δ = *C. lamottei*; ■ = *C. ngamensis*; ♦ = *C. anguillaris*; ◊ = *C. gariepinus*.

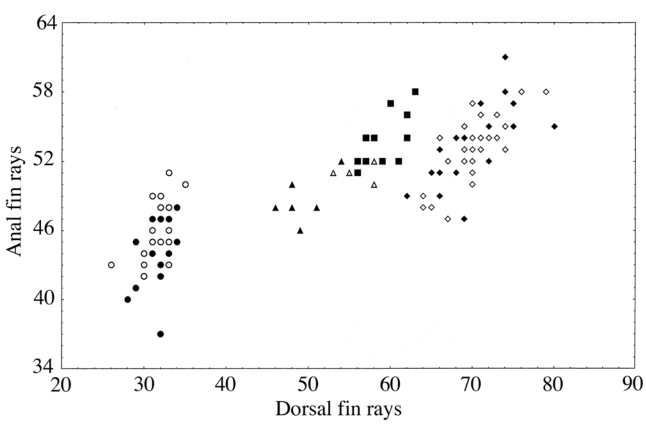


Figure 2. - Dorsal fin rays in relation to anal fin rays. ○ = *H. longifilis*; ● = *H. isopterus*; ▲ = *C. gariepinus* x *H. longifilis*; Δ = *C. lamottei*; ■ = *C. ngamensis*; ♦ = *C. anguillaris*; ◊ = *C. gariepinus*.

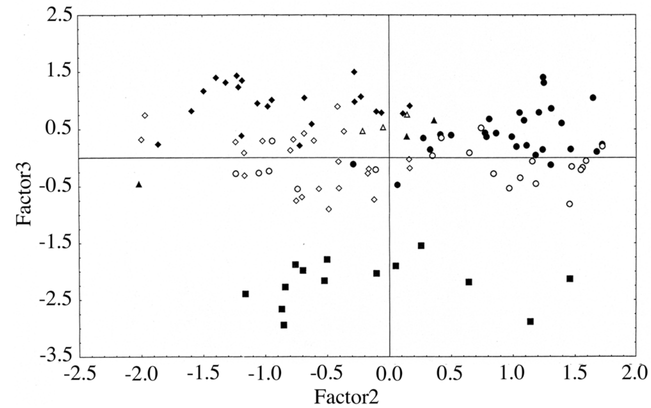


Figure 3. - Plot of the second and the third factors of a PCA using 12 log-transformed morphometric variables taken on 113 specimens of *Clarias* and *Heterobranchus* species. ○ = *H. longifilis*; ● = *H. isopterus*; ▲ = *C. gariepinus* x *H. longifilis*; Δ = *C. lamottei*; ■ = *C. ngamensis*; ♦ = *C. anguillaris*; ◊ = *C. gariepinus*.

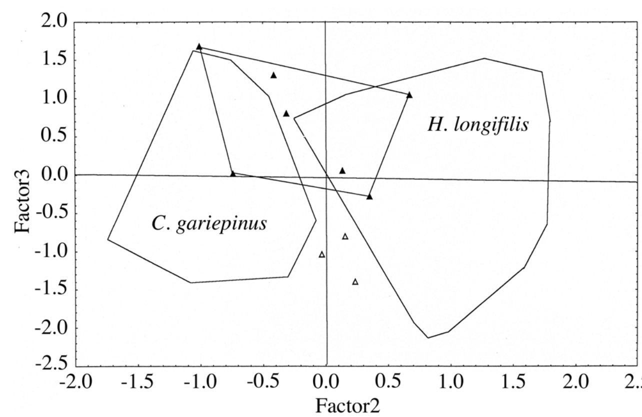


Figure 4. - Plot of the second and the third factors of a PCA using 11 log-transformed morphometric variables taken on 55 specimens of *Clarias* and *Heterobranchus* species. ▲ = *C. gariepinus* x *H. longifilis*; Δ = *C. lamottei*.

the dorsal and the caudal fins, the distance between the occipital process and the dorsal fin and the dorsal fin length. The artificial hybrids between *C. gariepinus* x *H. longifilis* and the *C. lamottei* types are all, except one, located near the centre of the plot, on the positive sector of the third component. The length of the vomerine toothplate easily distinguishes *C. ngamensis* from all the other taxa examined and the species is therefore excluded from further analysis.

From these preliminary results, *C. lamottei* seems morphometrically close to the artificial hybrids between *C. gariepinus* and *H. longifilis*, but notable differences are found. This is confirmed by the plot of the second and third factor of a PCA taken on 55 specimens of *C. gariepinus*, *H. longifilis*, their artificial hybrids and *C. lamottei* (Fig. 4). The artificial hybrids are overlapping with the parental species and are mostly situated on the positive sector of the third factor; the *C. lamottei* types are on the negative sector of the third factor. The third factor is defined (in decreasing order of importance) by the distance between the occipital process and the dorsal fin, the vomerine width and the premaxillary width; it explains 2.13% of the total variance.

Therefore, *C. lamottei* cannot be considered as a hybrid between *C. gariepinus* and *H. longifilis* and possible hybridisations between other parental species should be considered. These include: *C. gariepinus* x *H. isopterus*, *C. anguillaris* x *H. longifilis*, and *C. anguillaris* x *H. isopterus*.

Figure 5A shows the plot of the second and the fourth factor of a PCA using 11 log-transformed measurements (excluding standard length and vomerine length) taken on 52 specimens of *C. anguillaris*, *H. isopterus* and *C. lamottei*. The *C. anguillaris* and *H. isopterus* polygones are largely overlapping, while the *C. lamottei* types are distantly set on the negative sectors of the second and fourth factors. The second factor is defined (in decreasing order of importance) by the distance between the occipital process and the dorsal fin, the distance between the dorsal and the

caudal fins and the predorsal length. It explains 14.05% of the total variance. The fourth factor is merely defined by the premaxillary width, the preanal length and the dorsal fin length. It explains 0.32% of the total variance.

Figure 5B shows the plot of the second and the third factors of a PCA using 11 log-transformed measurements taken on 49 specimens of *C. anguillaris*, *H. longifilis* and *C. lamottei*. All *C. anguillaris* are located on the negative sector of the second component while most *H. longifilis* are on the positive sector. *C. lamottei* shows an intermediate position between both, but does not overlap with either of them. The second factor in this analysis is defined (in decreasing order of importance) by the distance between the dorsal and the caudal fins, the distance between the occipital process and the dorsal fin and the dorsal fin length; it explains 14.99% of the total variance.

Figure 5C illustrates the plot of the second and the third factors of a PCA using 11 log-transformed measurements, taken on 54 specimens of *C. gariepinus*, *H. isopterus* and *C. lamottei*. Most *C. gariepinus* are located on the negative sector of the second factor while most *H. isopterus* are on the positive sector of this factor. The *C. lamottei* specimens are all situated on the overlapping part between the two former species. I therefore conclude that this nominal species represents the hybrid between them.

Distribution data published by Teugels (1992) indicate that *H. longifilis* only occurs in the upper course of the Bandama Basin, while the type locality of *C. lamottei* is situated near the lower course, where *H. isopterus* is common. This distribution is consistent with *H. isopterus* being a parental species of this hybridisation.

The Bandama Basin, together with most other coastal basins from Côte d'Ivoire, is amongst the faunistically best known basins from Africa (Teugels *et al.*, 1988) and it has been sampled in detail. Note that Lévêque *et al.* (1977) reported *C. lamottei* also from the Nzi River on the Bandama, but without preserving specimens. The fact that *C. lamottei* is only known from its four type specimens all originating from the same locality is another argument in favour to demonstrate its hybrid nature.

It is most likely that these hybrids occurred naturally. Daget and Planquette (1967) mentioned that the type locality is a small pool that dries out completely every year. The hypothetical scenario for the hybridisation would than be that mature *C. gariepinus* and *H. isopterus* have been isolated in this pool. Reproduction of both species is similar and they both belong to the breeding guild of the non-guarders as described by Bruton (1996). Within this guild they belong to the egg-scatterers, which await suitable environmental conditions before spawning: gonadal maturation is associated with increasing water levels, temperature and photoperiod; fecundity is very high. With all these characteristics in common, chance

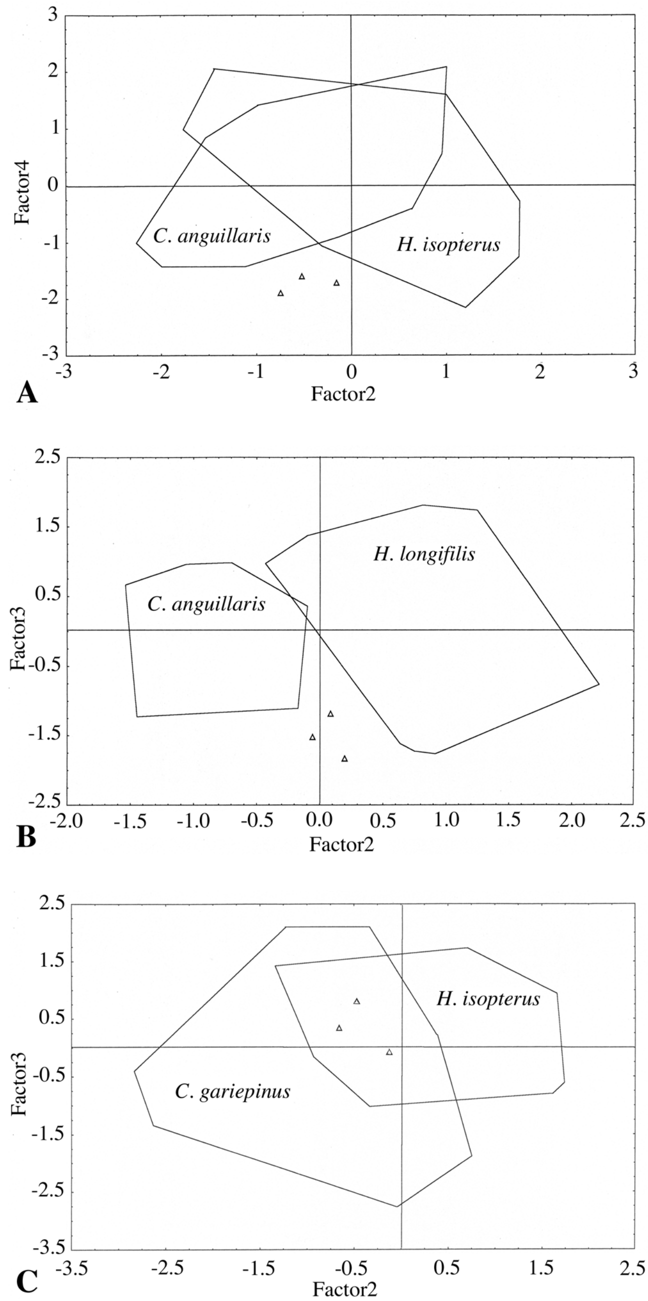


Figure 5. - **A**: Plot of the second and the fourth factors of a PCA using 11 log-transformed morphometric variables taken on 52 specimens of *Clarias* and *Heterobranchus* species. **B**: Plot of the second and the third factors of a PCA using 11 log-transformed morphometric variables taken on 49 specimens of *Clarias* and *Heterobranchus* species. **C**: Plot of the second and third factors of a PCA using 11 log-transformed morphometric variables taken on 54 specimens of *Clarias* and *Heterobranchus*. Δ = *C. lamottei*.

hybridisation cannot be excluded.

Natural intergeneric clariid hybrids have not been reported so far. Legendre *et al.* (1992) successfully performed reciprocal hybridisations between *C. gariepinus* and

H. longifilis. Similar hybridisations have been reported subsequently (Nwadukwe, 1995). Several interspecific artificial hybridisations for aquaculture purposes have been reported for *Clarias*, especially from South-East Asia. Agnèse *et al*. (1997) mentioned an hybrid between *C. gariepinus* and *C. anguillaris* from Senegal, but could not specify if it resulted from a natural or an artificial hybridisation.

Teugels (1986) placed *C. lamottei* in the subgenus *Clarias (Dinotopteroides)*. Based on the results of the present study, this subgenus now only includes *C. ngamensis*. This species is known from a vaste distribution range in southern Africa (Quanza and Cunene Rivers in Angola; the Okavango; Lake Ngami; the Upper Zambezi; Upper Lualaba; Lakes Bangweulu, Mweru and Malawi; and coastal rivers in Mozambique and South Africa). This pattern is in common to that of many other freshwater fishes of southern Africa (Skelton, 1993; 1994). The phylogenetic position of this species (and thus that of the subgenus) within the genus *Clarias* is questionable. It is diagnosed on the presence of the small adipose fin and in particular on the presence of extended neural spines supporting this fin (Teugels, 1986). Except for *C. ngamensis*, elongated neural spines supporting the adipose fin are only found in the clariid genera *Heterobranchus*, *Dinotopterus* Boulenger, 1906 and the recently rehabilitated *Bathyclarias* Jackson, 1959 (see Anseaume and Teugels, 1999). On the basis of this derived character, these taxa can be considered as forming a monophyletic group. The status of this group within the Clariidae is presently unknown and this is the subject of forthcoming research.

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